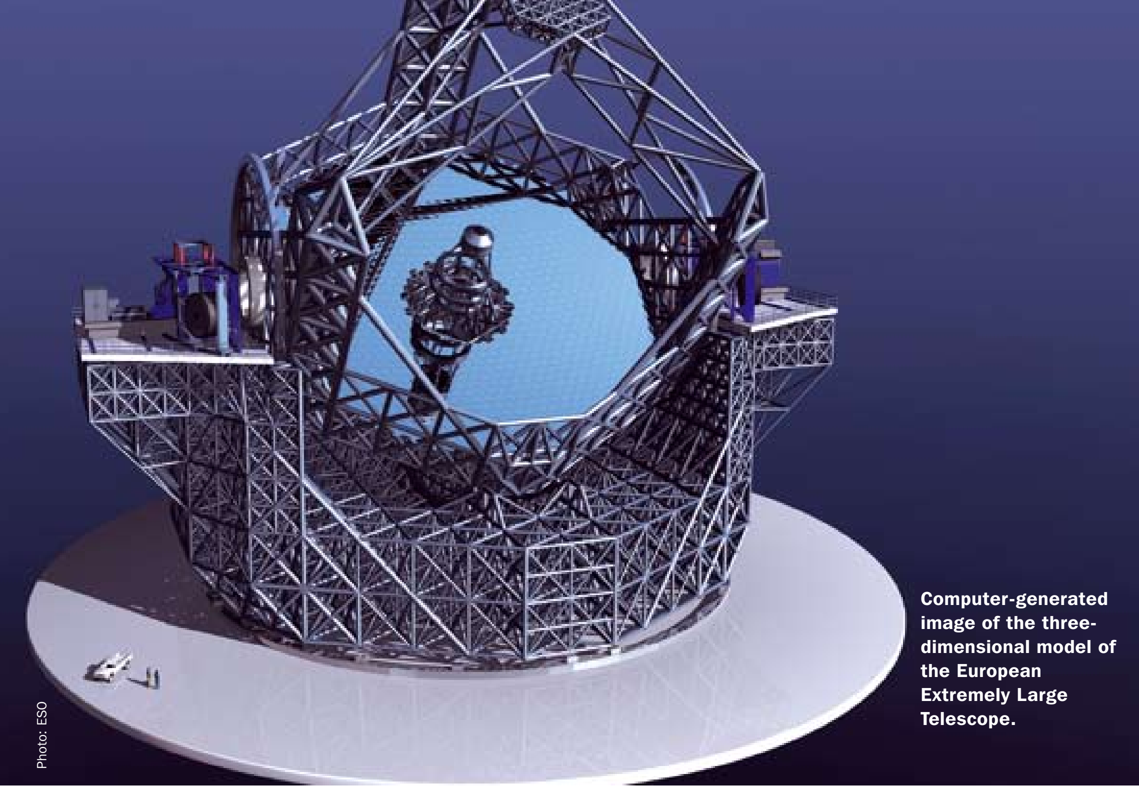

Photo: ESO

Computer-generated image of the three-dimensional model of the European Extremely Large Telescope.

ESO
The European Organisation for Astronomical Research in the Southern Hemisphere (ESO; www.eso.org) has been around since 1962 and currently comprises thirteen countries. The organisation, located in Garching near Munich, has been led for the past several months by a Dutchman in the person of professor Tim de Zeeuw from Leiden. The ESO has around 600 employees and a budget of some 120 million euros, paid by the member states. The ESO currently has telescopes at three sites in Chile. TNO has been working with the ESO for a long time. TNO was involved in the Very Large Telescope (VLT) that has been operating since 1997 from the 2600 metre Paranal mountain, close to the town of Antofagasta in north Chile, and it is still being extended. This telescope is the most powerful that the ESO currently has at its disposal.

Actuators for supertelescope

THREE MILLION STEPS TO FIFTEEN MILLIMETRES

The European organisation for southern hemisphere astronomical research, ESO, wants to start using the largest optical telescope ever built by around 2017. A 42-metre diameter mirror will enable the instrument to see a hundred times more than today's largest telescopes. TNO is involved in the preliminary studies.

At the end of 2006, the ESO Council decided to enter the phase of detailing the design for the new, 800 million euro European Extremely Large Telescope (E-ELT). 'TNO has been engaged for a year now in the development of an essential bit of engineering for the future supertelescope,' says TNO project manager Harm Hogenhuis.

That work, part of the preliminary studies for the E-ELT, concerns the development of an extremely precise control technology that will soon have to keep the heavy main mirror infallibly in position.

'The problem lies in the scale of this new telescope. The 42-metre wide main mirror will not be made of a single piece – it's simply too complex and expensive. Instead, the mirror will be built like a mosaic from a total of 906 hexagonal mirror elements, each with a diameter of 1.45 metres,' TNO systems engineer Jan Nijenhuis explains.

Those mirror elements will be manufactured from Zerodur (a type of glass that is not thermally distorted but is relatively heavy and is produced by the German company Schott), or a silicon carbide (a material that has a stiffness six times greater than that of glass, manufactured by the French company Boostec).

Photo: Fred Kamphues

TNO's Leo Ploeg integrates the first actuator (prototype).

Actuator technology

The mirror will be heavy, that's for sure. According to the ESO, the entire telescope will weigh around 5,500 tonnes. Underneath each mirror element three actuators will be placed to compensate for all the deformations caused by a segment (the underlying support structure is deformed by the fluctuating direction of gravity). In addition, the actuators will have to combat vibrations that occur as a result of air turbulence and ground movement.

'The technical challenge is to maintain the composition of the mirror elements correctly, otherwise you will get optical disruptions,' Hogenhuis says. 'Our project revolves around developing the actuator technology and manufacturing a test series.'

Nijenhuis: 'The telescope turns to follow the stars, which means that there is a corresponding shift in the gravity-related strain of the mirror. The support of the many hundreds of mirror elements has to be actively controlled therefore. And this calls for extraordinary precision: the requirement is to keep each element in position to within five nanometres.'

Nijenhuis and his team of TNO colleagues have made two prototypes of the actuator; in addition, eighteen have been manufactured in series through collaboration with the Bradford Engineering company in Heerle, in the Dutch province of Brabant.

Demonstrating compensation

Nijenhuis: 'The ultimate goal is to mount seven mirror panels on a frame that is representative of the future telescope. We can thus demonstrate that our actuators and the specially developed control software are able to compensate not only the large deformations by gravity but also the very small, high-frequency ground vibrations.'

Each actuator has to be able to support a weight of 170 kg and has a dynamic range of 15 mm – divided into three million five-nanometre steps. While the actuators are based on commercially obtainable components, the design is quite innovative.

The actuators were delivered at the end of October and are currently being built into a test set-up on the island of Tenerife. At the beginning of 2008 the ESO will start testing, and Hogenhuis expects TNO to be closely involved. As for the delivery of the thousands of actuators for the E-ELT main mirror, TNO may well have the role of main subcontractor and the actual work will be carried out by a manufacturing company.

Info: harmen.hogenhuis@tno.nl